Capturing Uncertainty in the Common Tactical-Environmental Picture

Murray Levine
College of Oceanic & Atmospheric Sciences
Oregon State University
104 Ocean Admin Bldg
Corvallis, OR 97331
phone: (541) 737-3047 fax: (541) 737-2064 email: levine@coas.oregonstate.edu

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LONG-TERM GOALS

The long-term goal of this study is to characterize and represent the uncertainty in describing environmental features that affect acoustic detection by submarines. We will investigate methods on how the uncertainty in our knowledge of the ocean and bottom affects acoustic propagation, acoustic signal processing and, ultimately, the detection, classification and localization of targets.

OBJECTIVES

The primary objective of this component of the project is to quantify the variability of the sound speed field in space and time due to internal waves. This wave-modulated sound speed field is then used by the acousticians to study the effects on acoustic propagation. Assessing the uncertainty in this estimate of internal wave variability will be an essential part of the study.

APPROACH

Initially, the approach is to focus on a particular location, the East China Sea, where there are significant acoustic observations during Sharem 134 that can be used for model comparison. The first step is to demonstrate that the uncertainty in the ocean and bottom can indeed be quantified and passed to each research group, culminating with an uncertainty estimate of the target on the submarine.

The initial approach of this component is to generate fields of realistic internal wave variability, assuming a sum of random waves as used in the Garrett-Munk spectrum. The parameterization of the wave field will follow the modifications for shallow water given by Levine (2002). The internal wave fluctuations are sensitive to the background density field, specifically the buoyancy frequency N(z). The resulting sound speed fluctuations also depend on the background sound speed profile c(z) which is primarily a function of temperature in this environment. Part of the problem is to determine the most representative background fields and the associated uncertainty.

A significant part of the internal wave field is most likely due to the internal tide and packets of nonlinear internal waves. We will explore methods to include these into the simulated internal wave fields.

To understand the effect of the internal wave fluctuations on the acoustics, constant feedback from the acousticians and signal processors is necessary. The hope is that we can determine the specific

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14. ABSTRACT
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features of the internal wave field that most affect the final target assessment. Then the goal is to quantify the importance of the internal waves probabilistically.

WORK COMPLETED

An initial estimate of acoustic sound speed fluctuations due to internal waves as a function of depth, range and time, was given to the acousticians at APL-UW. Their results were subsequently passed on to signal processors at ARL-UT and then to target trackers at Metron.

The environmental data available were temperature profiles from AXBTs made during the acoustic measurement of Sharem 134. Profiles were also obtained from the MODAS system and from Levitus climatology. In this shallow water region, MODAS was very similar to the Levitus climatology. The climatology was needed to infer the salinity field from the temperature observations using an averaged temperature-salinity (TS) relationship.

To begin the exploration of the sensitivity of the acoustics to the internal wave field, other realizations of the internal wave field were generated with varying amplitude of the waves, depths of the top and bottom mixed layers, and homogeneity of the mixed layers.

RESULTS

Based on the AXBT data taken during Sharem 134, an idealized profile was constructed (Figure 1). The associated density field was calculated using a climatological average TS relationship, and the N(z) estimated. The profile is quite different from the MODAS product. The recipe for calculating statistical realizations of the internal wave field in this environment was passed on to the acousticians at APL-UW. A variety of related idealized profiles with various internal wave statistics are also being tried (Figure 2).

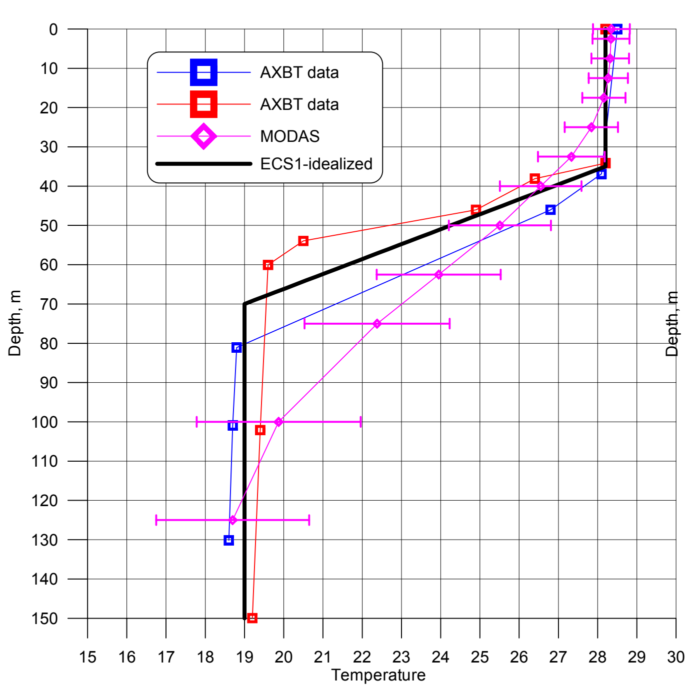

Figure 1

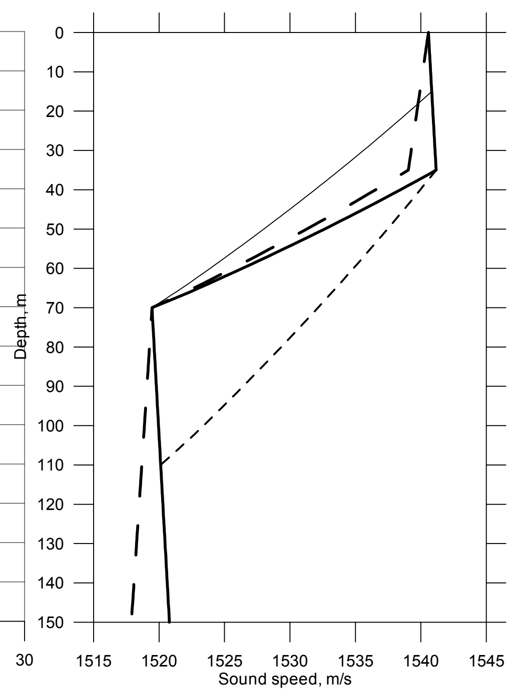

Figure 2

IMPACT/APPLICATIONS

The goal is to determine how the uncertainty due to the presence of internal waves affects the estimation of uncertainty in target detection on a submarine. If this proves important, then this study will help indicate the best way to input the internal wave contribution into an overall uncertainty estimate.

TRANSITIONS

The estimate of uncertainty in the internal wave field is a contribution that could potentially be used in a system to estimate overall target uncertainty on a submarine.

RELATED PROJECTS

This internal wave study is one component of a team effort lead by R. Miyamoto with participants from APL-UW, NRL-SSC, ARL-UT, Metron, and Navoceano.

The PI is involved in ongoing studies of the internal wave field in shallow water funded by ONR through award number N00014-95-1-0534.

REFERENCES

Levine, M.D., A modification of the Garrett-Munk internal wave spectrum, J. Phys. Oceanogr., (in press), 2002.